Bat Rabies in Canada: History, Epidemiology and Prevention

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History and Epidemiology

Rabies has been detected in 30 of 39 species of bats in North America (1). The first case of bat rabies reported in Canada was in British Columbia in 1957 (2, 3). The disease was later diagnosed in Ontario and Alberta in 1961 and 1971, respectively (4, 5).

Bats are the most widely distributed mammals reported rabid in Canada, but, in the past, have accounted for only 1% of the total diagnosed rabies cases (6). During the last decade (1976-1986), 557 bats were diagnosed rabid in eight provinces of Canada, the majority (74%) in Ontario and Alberta (Table I). The disease has been reported in several species of bats in Canada, the most common being big brown (*Eptesicus fuscus*), silver-haired (*Lasionycteris noctivagans*), hoary (*Lasiurus cinereus*), and little brown (*Myotis lucifugus*) bats (3, 6, 7, 8). All of the preceding bats are insectivorous; noninsectivorous bats have not been reported in Canada.

In the western Canadian provinces, the big brown bat is the species of bat most commonly diagnosed with rabies (9). It accounts for 95% of all diagnoses of bat rabies in Ontario (10).

Prevalence of rabies in insectivorous bats is usually about 1% in surveys of asymptomatic specimens. Infection rates for symptomatic suspect bats are approximately 5%, but vary on a species basis (7, 9). The peak of bat rabies usually occurs during August and September, in most provinces of Canada, when swarming behavior allows extensive interspecies and intraspecies contact among bats (6, 8, 9, 11).

In the past, it has been suggested that rabies in insectivorous bats in Canada is probably unrelated to other rabies enzootics in terrestrial mammals in Canada (12). Evidence to date has not proved otherwise. It appears that, in Canada, bats are not important sources of rabies infection for terrestrial mammals in that, in British Columbia, the disease is prevalent in bats in the absence of rabies in terrestrial mammals (6).

Pathogenesis

Although rabid bats are apparently not a major source of infection for land mammals, disease has been produced following natural and experimental infection in both Canada and the United States. Bell *et al* (13) detected rabies in mice following bite transmission by big brown bats, and Soave (14) diagnosed rabies in mice after they ingested rabies-infected bat tissue. Coyotes and foxes have developed rabies after experimental exposure to air in densely-populated bat caves (15, 16). As well, horses, cattle, cats, and humans have become infected with rabies following exposure to rabid bats in Canada and the United States (17, 18, 19, 20).

Incubation periods for rabies in bats are highly variable. Moore and Raymond (21) documented that clinical signs in big brown bats did not appear until at least seven weeks following infection, whereas the clinical period before death was an average of only five days. Incubation periods of 14-37 days are more common in experimentally inoculated bats. Virus may be shed in the saliva of bats for up to 12 days before clinical signs appear (22). Rabies virus has been isolated from various tissues in bats including brain, salivary gland, lung, kidney, adrenal, brown fat, and muscle (22).

Rabies virus is maintained in local bat populations by interaction among colonial and solitary species, latency in hibernating bats, transplacental transmission, and aggressive social interaction in colonial species. The great mobility of bats enables them to transmit rabies thousands of kilometers (7, 22).

Antigenic Differences

The detection of rabies neutralizing antibody can determine if a bat has been infected with the rabies virus (8, 23). Monoclonal antibody analysis, a relatively new advancement in rabies research, is capable of determining the specific viral strain. This tech-

TABLE I
Rabies in Bats in Canada (1976-1986)[a]

Province	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	Total
Ontario	9	17	14	22	32	19	22	47	51	35	45	313
British Columbia	8	8	1	5	10	8	7	9	5	11	9	81
Saskatchewan	6	9	5	4	3	3	2	2	3	7	5	49
Alberta	28	9	5	12	11	9	7	5	5	4	6	101
Manitoba	1								1			2
Quebec		2			1		2		2	1	1	9
Nova Scotia											1	1
New Brunswick									1			1
Total	52	45	25	43	57	39	40	63	68	58	67	557

[a]1976-1981 based on a fiscal year April 1-March 31.

nique has indicated that there are many strains of rabies virus. Antigenic differences in the virus occur among bat species and between geographic areas (24).

In Canada, four antigenically different viral strains have been identified in bats. The first type was identified in big brown bats from Ontario. A second type was found in several species of bats from British Columbia, Alberta, and Saskatchewan. Bats of the *Myotis* and *Lasionycteris* genera were detected with a third type in Ontario and New Brunswick. A fourth type was evident in big brown bats in Alberta and Saskatchewan (20). Recently, a horse which died of rabies in British Columbia succumbed to a virus identical to the second type of bat rabies strain, prevalent in western Canada (20, 25). To complicate the question of antigenicity even further, two different strains of rabies virus have been found in big brown bats from the same geographic area in the United States (24).

Human Exposure to Bat Rabies

In Ontario, only 2.9% (492/16,689) of the exposures of humans to potentially rabid animals were due to contact with bats between 1980-1986 (Table II). Considering the number of exposures to potentially rabid bats, transmission of rabies from rabid bats to humans in North America is quite rare. Of the 21 documented human rabies deaths in Canada since 1925, only three were known to have been due to contact with an infected bat (19). One occurred in Saskatchewan in 1970, another in Nova Scotia in 1977, and the most recent in Alberta in 1985 (19, 26). The situation is similar in the United States where, of the 38 human rabies cases between 1960-1980, four (11%) were positively identified as being due to infection by bats (27).

TABLE II
Human Postexposure Rabies Treatment because of Bat Contact in Ontario

Year	No. of Humans Treated	% of Total Human Exposures[a]
1980	45	2.5
1981	41	2.6
1982	61	2.5
1983	108	4.4
1984	78	3.8
1985	71	3.3
1986	88	2.1
Total	492	2.9

[a]A total of 16,689 people were given treatment in Ontario in this period.

Public Health Significance and Rabies Control

One of the most significant facts concerning bats and humans is that humans can succumb to rabies transmitted by contact with infected bats. As well, hundreds of humans have required costly postexposure treatment (about $500) due to contact with potentially rabid bats. Some species of bats, particularly big brown bats, tend to colonize around human habitations (9).

Of the 21 documented human rabies deaths in Canada since 1925, only three were known to have been due to contact with an infected bat.

This can be especially hazardous as big brown bats are the species of bat most often diagnosed in Canada as being rabid. Also of public health concern is that domestic pets and wild carnivores may be exposed to rabies through bats. Efficacy of current human rabies vaccines against the various strains of rabies virus that occur in bats is uncertain. Mice infected experimentally with bat virus isolated from a human were only partially protected by rabies vaccine (28).

Several measures can be undertaken to prevent human exposure to rabid bats. Most important is the need to educate the public, particularly children, of the dangers of rabies associated with handling bats. For example, in Texas in 1983, 11 children handled 29 bats that had fallen to the ground under a bridge. Most of the bats were not available for testing, so all of the children received rabies postexposure treatment (29). In a sample of 600 bats in Texas during 1983, 15% were positive for rabies (29). The importance of public education is no more evident than in the above case.

Since bats are capable of transmitting rabies to domestic pets, Trimarchi *et al* (18) recommend rabies vaccination of cats in areas where rabies is prevalent in bats. This should be done even where rabies is absent from terrestrial mammals because of the habit of domestic cats playing with dying bats (18). As well, due to the potential of bats to infect wild animals, any wild mammal that bites a human should be killed and submitted for rabies diagnosis even in areas free of terrestrial mammal rabies. The person should also report immediately to a physician for possible antirabies prophylaxis.

Population reduction or extermination of bats is generally not recommended for control of rabies, as some areas have low infection rates. In Florida, less than 0.1% of 6,000 bats examined for rabies between 1954-1961 were rabid (30). Similarly, in western Canada, only one of 769 bats collected during a survey from 1979 to 1983 was rabid (9).

To control bats effectively, one must be familiar with the biology of the species, especially whether they are colonial or solitary, migratory or nonmigratory. The major species diagnosed as rabid in Canada include the big brown, silver-haired, hoary, and little brown bat. The little brown and big brown bats are the most abundant in Canada and are colonial and usually live in buildings (33, 34, 35). Little brown bats are migratory, whereas big brown bats are relatively nonmigratory (7, 36). Both hoary and silver-haired bats are solitary and migratory; little is known of their habits (34, 37).

The most efficient means of bat control is exclusion from all buildings.

Removal of bats from human habitations or from areas frequented by children, such as schools, should be undertaken. This can be accomplished through the use of traps. As well, lights, lime, sulphur candles, formalin, and naphthalene flakes can be used to repel bats (22, 31). Although not recommended, toxicants such as DDT can also be used as a last resort to remove problem bat populations (32).

The most efficient means of bat control is exclusion from all buildings. In the case of migratory bats, this can be accomplished by waiting for bats to leave prior to migration and then sealing off all entry or exit holes

with screens or caulking compounds (22). If nonmigratory, access holes can be plugged after the bats have left for evening foraging. In any event, all human structures and residences should be made bat-proof.

Conclusion

The increasing numbers of rabies-positive bats are likely a function of increased awareness of the problem. A high number of submissions usually results in more cases diagnosed, as the prevalence of infection generally has remained the same in most surveys of bats. The best defense against bat rabies is to exclude bats from human habitations because mass destruction or vaccination of bats is not feasible. Persons in professions such as veterinary medicine, wildlife research, etc. who handle bats should receive pre-exposure immunization against rabies, even in an area where rabies is absent from terrestrial mammals. I am not aware of a person who has died of rabies when they had a titer considered to be protective against rabies at the time of contact.

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